REVIEW

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Behavioral Treatments of Chronic Tension-Type Headache in Adults: Are They Beneficial?

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To assess the efficacy of behavioral treatments in patients with tension headache. Medline, Cinahl, EMBASE, and the Cochrane library were searched from inception to October 2007 and reference lists were checked. We selected randomized trials evaluating behavioral treatments (e.g., relaxation, electromyographic [EMG] biofeedback, and cognitive behavioral training) in patients with tension-type headache (TTH). We assessed the risk of bias using the Delphi list and extracted data from the original reports. A qualitative analysis was carried out. We found 44 trials (2618 patients), which were included in this review, of which only 5 studies (11.4%) were considered to have low risk of bias. Most trials lacked adequate power to show statistical significant differences, but frequently, recovery/improvement rates did not reach clinical relevance. In 8 studies, relaxation treatment was compared with waiting list conditions, and in 11 studies, biofeedback was compared with waiting list conditions, both showing inconsistent results. On the basis of the available literature, we found no indications that relaxation, EMG biofeedback, or cognitive behavioral treatment is better than no treatment, waiting list, or placebo controls.

Introduction

Tension-type headache (TTH) or tension headache is the most commonly experienced type of headache. Population-based studies suggest prevalence rates of TTH of 35–40% in adults [1–3]. Chronic TTH has been defined in the classification of the International Headache Society (IHS) as more than 10 lifetime episodes of at least 6 months, with 15 or more headache episodes per month, an average episode duration of 30 min to 7 days, and with at least two quality of pain features (i.e., mild or moderate pain intensity, bilateral, pressing or tightening (non-pulsating) feeling, and no exacerbation by exercise) [4–6]. In addition, one associated symptom of migraine (i.e., nausea, vomiting, or photophobia and phonophobia) is permitted.

Several behavioral treatments such as relaxation, biofeedback, and cognitive behavioral (stress-management) therapy (CBT) are increasingly used in the management of TTH. Relaxation training is the less complicated behavioral strategy and is presumed to enable the headache sufferer to exert control over headache-related physiological responses and, more generally, sympathetic arousal [7]. Biofeedback uses electronic equipment to monitor physiological responses (that normally are unobservable) and reports it to the patients as visual or audio signals. The aim is that the patient learns to bring these normally involuntary processes under conscious control. The most frequently used type of biofeedback employed in the treatment of chronic TTH is electromyographic (EMG) biofeedback; this is feedback of electrical activity from muscles of the scalp, neck, and sometimes the upper body. There are conflicting opinions about the mechanism of biofeedback therapy in TTH, because reduction in the levels of muscle activity may neither be necessary nor be sufficient for the reduction in pain [8]. The use of CBT in headache management comes from the observation that the way individuals cope with everyday stresses can aggravate or maintain headaches and increase the disability and

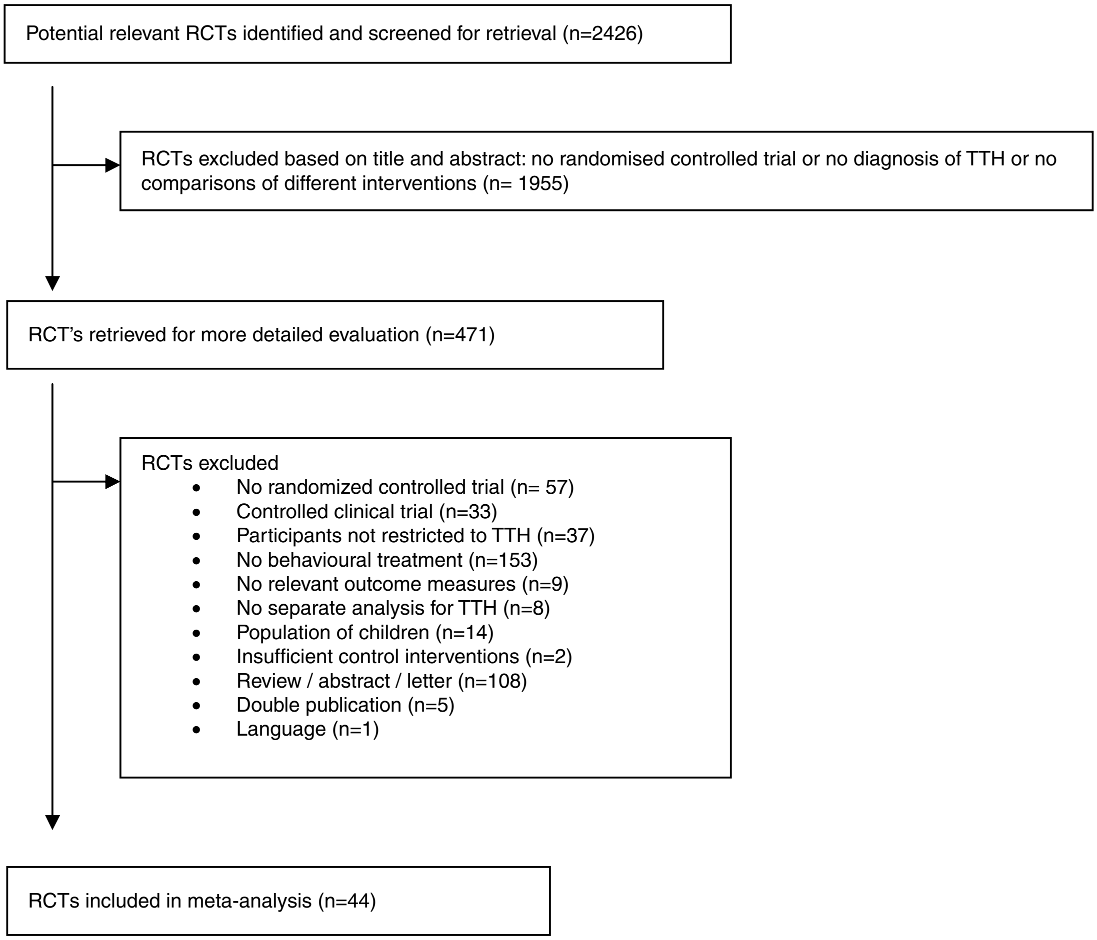

Figure 1 Flow chart

distress that are associated with headaches [9]. CBT focuses on the cognitive and affective components of headaches. Greater psychotherapeutic skills are required to administer CBT than to administer relaxation or EMG biofeedback training.

In the past, several systematic reviews on behavioral treatments of headaches have been performed. These reviews included various research designs such as controlled and noncontrolled trials, cohort designs, or patient series [10–12]. Furthermore, they included people with various types of headaches, often not well described according to predefined criteria. Recently, an evidence report was published including a review on behavioral strategies in patients with headaches [13]. Because we were unable to retrieve this report, it is unclear what method was used. The authors of the report concluded that all behavioral strategies are effective when compared with no treatment [14].

Well-performed systematic reviews form the basis for evidence-based treatment guidelines, which may improve the management of the treatment of individual patients. Therefore, we believe a well-performed systematic review on behavioral treatments is necessary because no valid and rigid overview exists. Therefore, the objective of this review was to describe and assess the evidence from randomized controlled trials (RCTs) concerning the efficacy of behavioral treatments in adult patients with chronic TTH.

Methods

Search Strategy

We searched Medline, PubMed, Cinahl, EMBASE, and the Cochrane Controlled Trials Register from inception to October 2007 using the terms "tension-type headache," "tension headache," "stress headache," and "muscle contraction headache," together with the search strategy for identifying RCTs [15]. Additional strategies for identifying trials included searching the reference lists of review articles and included studies.

Study Selection

We selected only RCTs including behavioral interventions used in the treatment or management of episodic or chronic TTH compared with no treatment, waiting list, or another treatment among adult patients (18 years or older), with criteria designed to distinguish TTH from migraine. The behavioral interventions considered included cognitive behavioral (or stress-management) therapy, EMG biofeedback training, and the broad categories of relaxation training: (1) progressive muscle relaxation [16], (2) autogenic training [17], and (3) meditation or passive relaxation [18].

TTH diagnoses had to be based on at least some of the distinctive features of TTH, for example, bilateral in location, no nausea or vomiting, mild or moderate intensity, or no exacerbation by exercise. Studies with at least one of the following outcome measures were included: headache intensity, frequency, duration, improvement, or index. No language restriction was applied.

Two of the authors first independently screened titles and abstracts of references identified by the literature search and then screened full papers for eligibility. Disagreements were resolved by consensus or by arbitration of a third author.

Risk of Bias Assessment

Two of the authors independently assessed the methodology of the included trials using the Delphi list [19]. This is a generic criteria list developed by international consensus and consists of the following items: (1) randomization, (2) adequate allocation concealment, (3) groups similar at baseline, (4) specification of eligibility criteria, (5) blinding of outcome assessor, (6) blinding of care provider, (7) blinding of patient, (8) presentation of point estimates and measures of variability, and (9) intention-to-treat-analysis. One extra item was added: (10) "withdrawal/dropout rate (>20% or selective dropout) unlikely to cause bias" because it was found relevant for these studies. All criteria were scored as yes (=1), no (=0) or do not know (=0). Disagreements were resolved by consensus or by arbitration of a third author. Reliability was calculated using kappa statistics. An overall score was computed by counting the number of positive scores. All studies receiving a score of 6 or more were regarded as having low risk of bias.

Data Extraction

Extraction of data from the original reports was performed by one of the authors and checked by a second author. Disagreements were resolved by consensus. The extracted information included demographical data, detailed description of the intervention and control treatment (i.e., dose given and study duration), outcome measures, and information on adverse effects.

Data Analysis

On the basis of the data presented in the original studies, we calculated standard mean differences (SMD) with 95% confidence interval (CI) for continuous outcomes or relative risks (RR) with 95% CI in cases of dichotomous outcomes. Data are presented as treatment success, indicating that an RR above 1 and an SMD above 0 represent a better outcome for the first mentioned intervention group.

We refrained from statistical pooling because of apparent clinical heterogeneity concerning patient population, interventions, and control treatments. We analyzed the results using different levels of evidence [20]. The evidence was judged to be strong when multiple trials with low risk of bias produced consistent findings [20]. The results were considered consistent if 75% or more of the studies reported similar results on the same outcome measure. It was judged to be moderate when one RCT with low risk of bias and/or multiple RCTs with higher risk of bias produced generally consistent findings. The evidence was considered to be limited when only one RCT existed and conflicting if the findings of existing trials were inconsistent. No evidence was considered when no RCTs were found or when the authors did not provide sufficient data for analysis [20]. We performed sensitivity analysis in studies having adequate power (at least 25 subjects per study arm), using the IHS or Ad Hoc criteria for patient selection, and low risk of bias.

Results

Search Results

A total of 2426 publications were identified by our search strategy (see Figure 1). Five articles were double publications [21–30], leaving a total of 44 RCTs included in this review.

Description of Studies

Participants

All studies found included patients with chronic TTH. The number of randomized participants in each trial ranged from 9 to 375 (mean 58 ± 74), with a total of 2618 patients included in this review. Most studies were (very) small; out of 132 study groups, 50 included no more than 10 subjects, and 46 included between 10 and 25 subjects in one of the study groups. The mean percentage of participants who dropped out from the trials was 21.4% (range 0–55.6%). The age of the participants ranged from 16 to 70 years. Four trials used the criteria of the IHS to classify chronic TTH, 16 trials used the Ad Hoc Committee's criteria, whereas the remaining studies used varying definitions (tension headache or muscle contraction headache).

Interventions

Eight studies compared relaxation with a control group receiving placebo relaxation (attention placebo control group), placebo medication, no treatment, or a waiting list control group [27,28,31–37]. Eleven studies compared EMG biofeedback with a control group receiving pseudo biofeedback, placebo medication, no treatment, or a waiting list control group [25,26,33,35,38–45]. Three studies compared relaxation + EMG biofeedback with a control group receiving placebo or no treatment [33,46,47], two studies compared cognitive behavioral therapy (CBT) with placebo or self-monitoring control [48,49].

The mean study duration was 27.5 (standard deviation [SD] 28.1) weeks, split into a mean baseline period of 2.9 (SD 1.5) weeks, a mean treatment period of 7.7 (SD 4.3) weeks, and a mean follow-up period of 17.0 (SD 26.9) weeks.

Outcome Measures

All studies used headache diaries to assess outcomes. Using this diary, headache frequency, intensity, and duration were scored on a Likert scale. In most studies, the original authors calculated a measure of clinical headache improvement: "HA improvement," and often headache (HA) improvement was defined as being clinically relevant when the patient's headache declines by 50% or more. Other outcome measures were analgesic use, depression, anxiety, EMG levels, or adverse events. Of all trials, 15 (34.1%) did not provide any data on outcome measures.

Risk of Bias

An overall score (with positive items in parentheses) is presented in the tables. The interobserver reliability of the risk of bias assessment was high (kappa = 0.81), with a high agreement (91.4%). After consensus, no disagreement persisted. The mean overall score was 3.8 (range 1–7). Using a cut-off point of 6 out of 10 criteria, only 5 studies (11.4%) were considered to have low risk of bias, but these were all of low power, so no sensitivity analysis could be performed [9,37,42,44,50]. The most prevalent methodological shortcomings were a concealed randomization method (negative 100%), intention-to-treat analysis (unclear 14% and negative 81%), and blinding of the care provider (unclear 88% and negative 5%).

Effectiveness of Behavioral Treatment

Relaxation Treatment

In six studies (n = 150), clinical-based relaxation was compared with home-based relaxation and no significant differences were found concerning HA improvement [52–56]. The mean difference between the groups in the percentage of patients improved was 9.7% (1–25%). Therefore, we decided to combine clinical- and home-based relaxation in comparisons with other treatment modalities.

Relaxation versus placebo/ no treatment or waiting list control

Of the eight studies in this category, one was considered having low risk of bias [37]. This study found significant HA improvement in the relaxation group compared with the waiting list and placebo groups [37]. The percentage of patients improved in the relaxation groups, compared with the control group, varied between 8 and 34%. One other study found significant HA improvement in the relaxation group compared with the discussion groups and waiting list control group, but this study suffered from large baseline differences. Furthermore, we doubt whether the SD intervals were actually standard error (SE) intervals [34]. Two studies did not provide sufficient data; all other studies found no significant differences between the groups. Four studies evaluated the effect of additional relaxation treatment compared with EMG biofeedback but did not provide sufficient data [23,24,33,41,46].

Relaxation versus relaxation

Three studies compared autogenic relaxation with self-hypnosis or hypnotic imagery (n = 200) and found no significant differences for headache index, depression, anxiety, and analgesic use [27–30,57]. No difference in the effect was found between relaxation and nonmuscular relaxation or "GSR" feedback (n = 31), but the difference in the percentage of patients improved was 29% in favor of the "GSR" feedback [21,22].

Table 1 Study characteristics of studies evaluating relaxation treatment

Study	Participants	Interventions	Outcome measures	Results post treatment (follow-up)
Appelbaum et al. [31] QS: 3 (item: 1, 3, 8)	TTH (Ad Hoc). N = 57. 73.2% female; mean age: 37.2 yrs.	***I: Home-based relaxation.*** Three sessions in 8 wks, N = 20, 4 dropouts. ***C1: Home-based relaxation + cognitive stress coping.*** Five sessions in 8 wks, N = 21, 4 dropouts ***C2: Waiting list control.*** N = 16, 8 dropouts.	***HA improvement*** ***HA diary:*** 6p Likert scale; 4 times/day; HA index. ***Analgesic use:*** index	***HA improvement:*** I: 40%; C1: 42.8%; C2: 6.25% I vs. C1: RR = 0.93 [0.45–1.94]; I vs. C2: RR = 6.4 [0.89–45.99]; C1 vs. C2: RR = 6.84 [0.96–48.73] I1 + C1 vs. C2: RR = 6.63 [0.96–45.83]
Arena et al. [51] QS: 5 (item: 1, 3, 4, 8, 10)	TTH (Ad Hoc). N = 27. 80.8% female; mean age: 39.5 yrs.	***I: Progressive muscle relaxation.*** Seven sessions in 8 wks, N = 8 ***C1: Frontalis EMG biofeedback.*** Twelve sessions, 6–9 wks, N = 9, 1 dropout. ***C2: Trapezius EMG biofeedback.*** Twelve sessions, 6–9 wks, N = 10	***HA improvement*** ***HA diary:*** 6p Likert scale; 4 times/day; HA index ***Analgesic use:*** index	***HA improvement:*** I: 37.5%; C1: 44.4%: C2: 100% I vs. C1: RR = 0.84 [0.27–2.68]; I vs. C1 + C2: RR = 0.51 [0.2–1.3]
Attanasio et al. [52] QS: 3 (item: 1, 3, 8)	TTH (Ad Hoc). N = 25, 4 dropouts. 72.0% female; mean age: 36.8 yrs.	***I: Home-based relaxation.*** Three sessions in 8 wks + 2 telephone contacts, N = 6 ***C1: Home-based relaxation + cognitive treatment.*** Five sessions in 8 wks + 1 telephone contact, N = 8 ***C2: Clinical-based relaxation + cognitive treatment.*** Eleven sessions in 8 wks, N = 7	***HA improvement*** ***HA diary:*** 6p Likert scale; 4 times/day; HA index ***Analgesic use:*** index	***HA improvement:*** I: 50%; C1: 62.5%: C2: 71.4% I vs. C1: RR = 0.8 [0.31–2.10] I vs. C2: RR = 0.7 [0.28–1.77] C1 vs. C2: RR = 0.88 [0.43–1.78] I vs. C1 + C2: RR = 0.75 [0.31–1.8]
Blanchard et al. [53] QS: 4 (item: 1, 3, 8, 10)	**Study 1.** TTH (Ad Hoc). N = 62. 58.5% female; mean age: 35.9 yrs.	***I: Clinical-based relaxation.*** Ten sessions in 8 wks, N = 29, 3 dropouts. ***C: Home-based relaxation.*** Three sessions in 8 wks, N = 33, 6 dropouts.	***HA improvement*** ***HA diary:*** 6p Likert scale; 4 times/day; in HA index ***Analgesic use:*** index	***HA improvement:*** I: 31%; C: 30.3% I vs. C: RR = 1.02 [0.48–2.17]

Relaxation versus biofeedback

Seven studies compared EMG biofeedback with relaxation [23,24,33,35,51,59–61]. Only two studies (n = 84) provided sufficient data and found no significant differences between EMG biofeedback and relaxation for HA improvement [51,59].

Relaxations versus other interventions

Four studies [34,50,61,62] compared relaxation with other interventions, of which two provided sufficient data [34,50]. The one study with low risk of bias found a statistical significant benefit of cognitive coping compared with relaxation [50]. Relaxation and rational

Table 1 Continued.

Study	Participants	Interventions	Outcome measures	Results post treatment (follow-up)
Blanchard et al. [55] QS: 3 (item: 1, 3, 8)	TTH (Ad Hoc). N = 31, 12 dropouts. 63.2% female; mean age: 39.4 yrs.	***I: Clinical-based relaxation + minimal contacts.*** Ten sessions in 8 wks + 3 contacts at 3, 6, and 12 mo, N = 8 ***C1: Clinical-based relaxation + monthly contact.*** Ten sessions in 8 wks + monthly contact, N = 3 ***C2: Home-based relaxation + minimal contact.*** Three sessions in 8 wks + 3 contacts at 3, 6 and 12 mo, N = 6 ***C3: Home-based relaxation + monthly contact.*** Three sessions and 2 telephone contacts in 8 wks + monthly contact, N = 2	***HA diary:*** 6p Likert scale; 4 times/day; HA index	***HA index:*** I: 2.5 (SD 2.5); C1: 6.4 (SD 7.7); C2: 4.3 (SD 4.1); C3: 4.5 (SD 4.8) I vs. C1: SMD = 0.84 [−0.53–2.21] I vs. C2: SMD = 0.51 [−0.56–1.59] I vs. C3: SMD = 0.62 [−0.95–2.2]
Blanchard et al. [32] QS: 3 (item: 1, 3, 8)	TTH (Ad Hoc). N = 77. 62.1% female; mean age: 38.3 yrs.	***I1: Clinical-based relaxation.*** Ten sessions in 8 wks, N = 22, 3 dropouts. ***I2: Clinical-based relaxation + cognitive stress coping.*** Eleven sessions in 8 wks, N = 17, 1 dropout. ***C1: Attention placebo control.*** Eleven sessions in 8 wks, N = 19, 3 dropouts. ***C2: HA monitoring waiting list control.*** N = 19, 4 dropouts.	***HA improvement*** ***HA diary:*** 6p Likert scale; 4 times/day; HA index ***Analgesic use:*** index	***HA improvement:*** I: 27.3%; C1: 58.8%; C2: 36.8%; C3: 15.8% I1 vs. I2: RR = 0.46 [0.21–1.02] I1 vs. C1: RR = 0.74 [0.3–1.82] I1 vs. C2: RR = 1.73 [0.5–5.98] I (1 + 2) vs. C (1 + 2): RR = 1.56 [0.8–2.99]
Chesney and Shelton [33] QS: 3 (item: 1, 9, 10)	TTH. N = 24, no dropouts. 91.7% female.	***I: Muscle relaxation.*** Three sessions in 2 wks, N = 6 ***C1: EMG biofeedback.*** Ten sessions: 8 sessions of frontalis EMG 4 times a wk for 2 wks, N = 6 ***C2: Muscle relaxation + EMG biofeedback.*** N = 6 ***C3: No treatment condition.*** N = 6	***HA diary:*** VAS, frequency (times/wk) and duration (hrs/HA)	No sufficient data to calculate RR or SMD

emotive therapy seem to be equally effective, but relaxation is more effective in pain reduction than headache discussion therapy [34]. This conclusion should be viewed with caution because of the large baseline differences and the probably incorrect SDs [34]. Two studies evaluated the influence of the therapist and found that the therapist did not seem to influence the headache index [37,55].

Table 1 Continued.

Study	Participants	Interventions	Outcome measures	Results post treatment (follow-up)
Cochrane et al. [46] QS: 2 (item: 1, 4)	TTH (Ad Hoc). N = 53, 5 dropouts.	***I: EMG biofeedback.*** Four weakly sessions of frontalis EMG sessions, N = ? ***C1: EMG biofeedback + relaxation.*** Four weakly sessions of frontalis EMG sessions + relaxation, N = ? ***C2: Hypnotic analgesia.*** Four weakly sessions, N = ?	***HA diary:*** VAS and frequency (hrs/wk)	No sufficient data to calculate RR or SMD
Collet et al. [21,22] QS: 4 (item: 1, 3, 8, 10)	TTH (Ad Hoc). N = 31. 51.6% female; mean age: 39.7 yrs.	***I: Relaxation.*** Ten sessions of 36 min, N = 15, 3 dropouts. ***C: Non-muscular relaxation.*** Ten sessions of 36 min, GSR feedback training, N = 16, 3 dropouts.	***HA improvement*** ***HA diary:*** 6p Likert scale, ***McGill–Melzack Pain Questionnaire*** ***Anxiety:*** 6p Likert scale ***Analgesic use:*** nr/wk	***HA improvement:*** Intensity I: 33.3%; C: 62.5% Intensity I vs. C: RR = 0.53 [0.24–1.2] Frequency I vs. C: RR = 0.18 [0.03–1.29] ***Anxiety improvement:*** I vs. C: RR = 0.89 [0.25–3.14]
Finn et al. [34] QS: 2 (item: 1, 8)	TTH. N = 48. 65.7% female; mean age: 32.94 yrs.	***I: Relaxation.*** Ten sessions of weekly progressive muscle relaxation + home practice, N = 12, 4 dropouts. ***C1: Rational Emotive Therapy (RET).*** Ten sessions weekly, N = 12, 4 dropouts. ***C2: Headache discussion.*** Ten sessions of weekly discussion + home practice, N = 12, 2 dropouts ***C3: Waiting list HA self-monitoring control.*** N = 12, 3 dropouts.	***HA improvement*** ***HA diary:*** 5p Likert scale, frequency (HA/wk), duration (hrs/wk) ***Minnesota Multiphasic Personality Inventory*** ***Frontalis EMG***	***HA improvement:*** I: 1.24 (SD 0.4); C1: 1.35 (SD 0.45); C2: 2.7 (SD 0.2); C3: 2.68 (SD 0.26) I vs. C1: SMD = 0.25 [−0.55–1.05] I vs. C2 SMD = 4.44 [2.95–5.93] I vs. C3 SMD = 4.11 [2.7–5.5] I vs. C1: SMD = 0.79 [−0.24–1.82] I vs. C2: SMD = −0.69 [−1.66–0.27] ***HA frequency:*** I vs. C1: SMD = −0.28 [−1.26–0.71] I vs. C2: SMD = 3.46 [1.88–5.04] I vs. C3: SMD = 2.75 [1.33–4.17] Note: significant baseline differences!

We conclude that there is conflicting evidence that relaxation is better than no treatment, waiting list, or placebo. No statistical significant differences in the effect were found between relaxation and biofeedback, "GSR" feedback, self-hypnosis, and rational emotive therapy.

EMG Biofeedback Treatment

EMG biofeedback versus placebo/ no treatment or waiting list control

Eleven studies in this category, including two studies with low risk of bias, were showing inconsistent results

Table 1 Continued.

Study	Participants	Interventions	Outcome measures	Results post treatment (follow-up)
Gada [59] QS: 5 (item: 1, 3, 4, 8, 10)	TTH (Ad Hoc). N = 65. 67.2% female; mean age: 35.8 yrs.	***I: Progressive muscular relaxation.*** Twenty sessions, for 10 wks; N = 32, 4 dropouts. ***C: EMG biofeedback.*** Twenty sessions of frontalis EMG sessions, for 10 wks; N = 33, 3 dropouts.	***HA improvement*** ***HA diary:*** 6p Likert; HA index	***HA improvement***: I: 2.5 (SD 0.5); C: 2.4 (SD 0.4) Improvement: I vs. C: SMD = −0.22 [−0.71–0.27] Intensity I vs. C: SMD = 0.26 [−0.26–0.78] HA-free days I vs. C: SMD = 0.0 [−0.52–0.52]
Gray et al. [60] QS: 2 (item: 1, 4)	TTH. N = 20, 5 dropouts. 60.0% female; mean age: 38.8 yrs.	***I: Direct EMG biofeedback.*** Six weakly sessions of frontalis and trapezius EMG; N = ? ***C1: Indirect EMG biofeedback.*** Six weakly sessions of frontalis and trapezius EMG; N = ? ***C2: Relaxation instructions.*** Six sessions of relaxation instructions + home practice, N = ?	***HA diary:*** 5p Likert scale, frequency and duration ***Analgesic use***	No sufficient data to calculate RR or SMD
Haynes et al. [35] QS: 1 (item: 1)	TTH. N = 21. 66.7% female; mean age: 20.9 yrs.	***I: Relaxation.*** Six sessions twice weekly, N = 8, 2 dropouts. ***C1: EMG biofeedback.*** Six sessions of frontalis EMG, twice a wk, N = 8, 2 dropouts. ***C2: No treatment control.*** N = 5, 1 dropout.	***HA diary:*** 11p Likert scale, frequency, duration; HA index	No sufficient data to calculate RR or SMD
Hutchings and Reinking [23,24] QS: 1 (item: 1)	TTH. N = 30, 12 dropouts. 77.8% female; mean age: 23 yrs.	***I: Relaxation.*** Ten sessions of autogenic relaxation training in 5–7 wks, N = ? ***C1: EMG biofeedback.*** Ten sessions of forehead EMG relaxation training in 5–7 wks, N = ? ***C2: EMG biofeedback + relaxation.*** Ten sessions of forehead EMG training + autogenic relaxation training in 5–7 wks, N = ?	***HA diary:*** 5p Likert scale and frequency; HA index ***EMG levels frontalis***	No sufficient data to calculate RR or SMD

(see Table 2) [42,44]. Only three studies provided sufficient data on headache measures [42–44]. In one study, data on HA improvement showed a significant effect of biofeedback, whereas for data on depression, there were no significant differences between the groups [43]. Two studies evaluated the effect of additional EMG biofeedback compared with relaxation but presented no data [23,24,33].

Table 1 Continued.

Study	Participants	Interventions	Outcome measures	Results post treatment (follow-up)
Infantino et al. [50] QS: 7 (item: 1, 3, 4, 5, 7, 8, 10)	TTH (Ad Hoc). N = 27. 34.8% female; mean age: 40 yrs.	***I: Relaxation.*** Eight weekly sessions, N = 13, 2 dropouts. ***C: Cognitive coping.*** Eight weekly sessions, N = 14, 2 dropouts.	***HA improvement*** ***HA diary:*** 6p Likert scale; HA index, frequency (nr/wk)	***HA improvement*** I: 15.4%; C: 64.3% I vs. C: RR = 0.24 [0.06–0.91]
Janssen [41] QS: 2 (item: 1, 3)	TTH. N = 18, no dropouts. 77.8% female; mean age: 34.6 yrs.	***I: EMG biofeedback.*** Twelve sessions for 6 wks of frontalis EMG, N = 6 ***C1: EMG biofeedback + relaxation.*** Two relaxation sessions + home exercises + 10 sessions for 5 wks of frontalis EMG, N = 6 ***C2: Waiting list control.*** Baseline, 5 wks waiting, 3 recording sessions in 18 days, N = 6	***HA diary:*** 6p Likert scale and duration; HA index ***EMG levels frontalis and neck***	No sufficient data to calculate RR or SMD
Janssen and Neutgens [58] QS: 1 (item: 1)	TTH. N = ?, N = 10 completed.	***I: Autogenic training.*** Twelve sessions once a wk, N = ? ***C: Progressive relaxation.*** Twelve weekly sessions, N = ?	***HA diary:*** 11p Likert scale, frequency, duration	No sufficient data to calculate RR or SMD
Jurish et al. [54] QS: 3 (item: 1, 3, 8)	Mixed (Ad Hoc). N = 20 completed. 77.5% female; mean age: 37.4 yrs.	***I: Clinical-based relaxation + thermal biofeedback.*** Sixteen sessions of 60 min in 8 wks of relaxation, N = 11 ***C: Home-based relaxation + thermal biofeedback.*** Three sessions, N = 9	***HA improvement*** ***HA diary:*** 6p Likert scale (four times/day) ***Analgesic use:*** index	***HA improvement*** I: 63.6%; C: 88.8% I vs. C: RR = 0.72 [0.43–1.18]
Loew et al. [36] QS: 4 (item: 1, 4, 8, 10)	TTH (IHS). N = 54. 79.2% female; mean age: 39.4 yrs.	***I: Relaxation.*** One session of relaxation training, (body awareness) + home practice, for 8 wks, N = 27, 15 dropouts. ***C: Placebo treatment.*** One session of isotonic exercises of one hand, home practice, for 8 wks, N = 27, 15 dropouts.	***HA improvement*** ***HA diary:*** 3p Likert scale, duration (days/8.5 wks) ***Analgesic use***	***HA improvement*** I: 18.5%; C: 0%

EMG biofeedback versus EMG biofeedback

Five studies evaluated different forms of EMG biofeedback [9,40,51,60,63]. Two studies provided sufficient data and found no statistical significant differences in HA improvement [51,63].

EMG biofeedback training versus other treatments

One study (low risk of bias and low power) compared EMG biofeedback with diazepam and did not find statistical significant differences [44]. EMG biofeedback was compared with amitriptyline or propranol in one study,

Table 1 Continued.

Study	Participants	Interventions	Outcome measures	Results post treatment (follow-up)
Reich [61] QS: 1 (item: 1)	TTH. N = ?, N = 311 completed. 52% female.	***I: EMG biofeedback.*** Ten sessions for 15 wks of frontalis, trapezius or paracervical EMG sessions + home practice, N = 78 ***C1: Relaxation.*** Cognitive-oriented psychotherapy, hypnosis, or autogenic training/progressive muscle relaxation, single or in combination + home practice, N = 78 ***C2: Electrical treatment.*** Traditional TENS or electrical neurotransmitter modulation, single or in combination, N = 74 ***C3: Combination treatment.*** A combination of two of the above treatment groups, N = 81	***HA diary:*** 5p Likert scale and frequency (hrs/wk)	No sufficient data to calculate RR or SMD
Rokicki et al. [47] QS: 5 (item: 1, 3, 4, 8, 10)	TTH (IHS). N = 45. 86% female; mean age: 18.8 yrs.	***I: EMG biofeedback + relaxation.*** Twice weekly for 6 wks of frontalis and trapezius EMG sessions + relaxation, N = 30, 1 dropout. ***C: Control group.*** Three sessions weekly, only exteroceptive suppression period (ES2) recorded, N = 15, 2 dropouts.	***HA diary:*** 11p Likert scale; HA index ***Headache-Specific Locus of Control Scale*** ***HA Self-Efficacy Scale*** ***Analgesic use:*** nr/wk	***HA index*** I: 1.4 (SD 1.2); C: 2.5 (SD 1.5) I vs. C: SMD = 0.83 [0.18–1.47]
Sethi et al. [64] QS: 4 (item: 1, 3, 4, 10)	TTH. N = 16, 3 dropouts. 53.8% female; age range: 16–45 yrs.	***I: EMG biofeedback + relaxation.*** Twice weekly for 10 wks of frontalis EMG sessions + 4 sessions of relaxation, N = 8, 2 dropouts. ***C: Shavasana*** (relaxation of body and mind with yoga)**.** Twice weekly for 10 wks, N = 8, 1 dropout.	***HA diary:*** 5p Likert scale ***Social adjustment***	***HA intensity*** I: 1.33 (SD 1.75); C: 1.0 (SD 1.41) I vs. C: SMD = −0.2 [−1.18–0.79]
Söderberg et al. [62] QS: 5 (item 1, 4, 8, 9, 10)	TTH. (IHS) N = 90, 55 dropouts. 81% female; age range: 18–59 yrs	***I: Relaxation training.*** Autogenic relaxation techniques. 8–10 sessions once a wk. Audiotape for home practice. N = 30, 11 dropouts ***C1: Physical training.*** Ten training sessions + home training for 10 wks. N = 30, 11 dropouts ***C2: Acupuncture.*** 10–12 sessions during a period of 12 wks. N = 30, 13 dropouts	***HA intensity:*** VAS scale ***HA-free days***: HA diary ***HA-free periods:*** HA diary	No sufficient data to calculate RR or SMD

Table 1 Continued.

Study	Participants	Interventions	Outcome measures	Results post treatment (follow-up)
Spinhoven et al. [57] QS: 4 (item: 1, 4, 8, 10)	TTH. N = 56. 60.9% female; mean age: 36 yrs.	***I: Autogenic relaxation.*** Four sessions in 7 wks, home training 25 hrs, N = 28, 8 dropouts. ***C: Self-hypnosis.*** Four sessions in 7 wks, home training, N = 28, 8 dropouts.	***HA diary:*** 6p Likert scale; in HA index ***Symptom Checklist-90*** ***Coping Strategy Questionnaire*** ***Analgesic use***	***HA index:*** I: 2.5 (SD 1.5); C: 2.9 (SD 2.5) I vs. C: SMD = 0.2 [−0.4–0.85] (6 mo I vs. C: SMD = 0.22 [−0.4–0.85])
Teders et al. [56] QS: 4 (item: 1, 3, 8, 10)	TTH (Ad Hoc). N = 40, 5 dropouts. 57.1% female; mean age: 36.9 yrs.	***I: Clinical-based relaxation.*** Ten sessions in 8 wks, N = 17 ***C: Home-based relaxation.*** Three sessions in 8 wks + 2 telephone contacts, N = 18	***HA diary:*** 6p Likert scale HA index ***Analgesic use:*** index	***HA index:*** I: 4.94 (SD 3.89); C: 4.6 (SD 4.15) I vs. C: SMD = −0.08 [−0.75–0.58]
Ter Kuile et al. [27,28] QS: 4 (item: 1, 4, 8, 10)	TTH. N = 157.	***I: Autogenic relaxation.*** Seven weekly sessions, N = 48, 7 dropouts. ***C1: Self-hypnosis.*** Seven weekly sessions of relaxation, imaginative inattention, pain displacement and transformation, hypnotic analgesia, N = 52, 12 dropouts. ***C2: Waiting list control.*** N = 57, 4 dropouts.	***HA diary;*** 6p Likert scale (four times/day) ***Symptom Checklist-90*** ***Stanford Hypnotic Clinical Scale for Adults*** ***Analgesic use:*** nr/wk	***HA index:*** I: 16.2 (SD 12.1); C1: 22.5 (SD 14.8); C2: 25.4 (SD 16) I vs. C1: SMD = 0.46 [0.02–0.90]; I vs. C2: SMD = 0.63 [0.21–1.05]; C1 vs. C2: SMD = 0.19 [−0.23–0.6] (6 mo I vs. C1: SMD = 0.27 [−0.17–0.7])
Tobin et al. [65] QS: 5 (item: 1, 3, 4, 8, 10)	TTH. N = 27. 71.0% female; mean age: 28 yrs.	***I: Home-based relaxation.*** Three sessions in 8 wks, N = 13, 1 dropout. ***C: Home-based relaxation + cognitive behavioral.*** Three sessions in 8 wks + once per wk stress management, problem-solving skills, N = 14, 2 dropouts.	***HA diary:*** 11p Likert scale HA index ***Beck Depression Inventory (BDI)***	***HA index*** I: 1.99 (SD 2.27); C: 0.74 (SD 0.94) I vs. C: SMD = −0.71 [−1.49–0.07] (3 mo I vs. C: SMD = −0.78 [−1.61–0.06]) ***BDI:*** I vs. C: SMD = −0.39 [−1.2–0.42]

and HA improvement was significantly lower in the biofeedback group compared with the medication groups, whereas depression was only significantly lower in the EMG biofeedback group when compared with propranol [43]. Three other studies evaluated EMG biofeedback compared with an electrical treatment or hypnotic analgesia but did not provide sufficient data [25,26,46,61].

Although the differences between the groups might be clinically meaningful, because of the low power, we conclude that there is conflicting evidence to support or refute the effectiveness of EMG biofeedback compared with placebo to prophylactic drugs or any other treatment.

Relaxation Treatment + EMG Biofeedback Training

Relaxation + EMG biofeedback versus placebo/ no treatment or waiting list control

Three studies compared relaxation + EMG biofeedback with waiting list condition or attention placebo

Table 1 Continued.

Study	Participants	Interventions	Outcome measures	Results post treatment (follow-up)
Wallbaum et al. [68] QS: 1 (item: 1)	TTH. N = 40. 80.6% female; mean age: 33.7 yrs.	***I: Relaxation + chamber condition.*** Twice weekly for 4 wks, progressive muscles relaxation in room with minimal rest condition, N = 15, 5 dropouts during treatment, 4 during follow-up. ***C1: Relaxation + tank condition.*** Twice weekly for 4 wks, once a wk progressive muscles relaxation in flotation tank, N = 10, 5 dropouts during follow-up. ***C2: Chamber + tank condition.*** Twice weekly for 4 wks, once a wk in room with minimal rest condition, once a wk in flotation tank, N = 7, 1 dropout during treatment, 2 during follow-up. ***C3: Chamber condition (control).*** Twice weekly for 4 wks in room with minimal rest condition, N = 8, 3 dropouts during treatment.	***HA improvement*** ***HA diary:*** intensity, frequency, duration; HA index	***HA improvement*** I: I vs. C1: RR = 0.67 [0.27–1.66]; I vs. C3: RR = 1.0 [0.27–3.27]; C1 vs. C3: RR = 1.5 [0.46–4.91]; (4 mo I vs. C1: RR = 6.0 [0.38–94.35]; I vs. C3: RR = 2.5 [0.36–17.17]; C1 vs. C3: RR = 0.33 [0.02–6.65])
Wojciechowski [37] QS: 6 (item: 1, 4, 5, 6, 7, 8)	TTH + mixed (Ad Hoc). N = 68. 100% female; mean age: 32.6 yrs	***I: Relaxation + believe therapist relaxation.*** Eight weekly sessions of relaxation, N = 14, 4 dropouts. ***C1: Relaxation + believe therapist placebo.*** Eight weekly sessions of relaxation, N = 14, 3 dropouts. ***C2: Placebo + believe therapist placebo.*** Eight weekly sessions of relaxation without muscle relaxation exercises, N = 13, 4 dropouts. ***C3: Placebo + believe therapist relaxation.*** Eight weekly sessions of relaxation without muscle relaxation exercises, N = 13, 6 dropouts. ***C4: Waiting list control.*** N = 14, 2 dropouts.	***HA diary:*** 12p Likert scale, HA index	***HA index:*** I: 43 (SD 62); C1: 123 (SD 88); C2: 174 (SD 177); C3: 264 (SD 121); C4: 238 (SD 189) I vs. C1: SMD = 1.02 [0.23–1.81]; I vs. C3: SMD = 2.26 [1.29–3.22]; I vs. C4: SMD = 1.35 [0.53–2.17]; (2 mo I vs. C1: SMD = 0.76 [−0.13–1.66]; I vs. C3: SMD = 0.9 [−0.13–1.92])

Table 1 Continued.

Study	Participants	Interventions	Outcome measures	Results post treatment (follow-up)
Zitman et al. [29,30] QS: 5 (item: 1, 3, 4, 8, 10)	TTH. N = 96. 54.3% female; mean age: 36 yrs.	***I: Autogenic relaxation.*** Four therapy sessions in 7 wks with pre- and posttreatment session, home training relaxation, N = 28, 7 dropouts during follow-up. ***C1: Future-oriented hypnotic imagery.*** Four therapy sessions in 7 wks with pre- and posttreatment session, home training, N = 27, 6 dropouts during follow-up. ***C2: Hypnotic future-oriented imagery.*** Four therapy sessions in 7 wks with pre- and post treatment session, home training, N = 24	***HA diary:*** 11p Likert scale; HA index ***State-Trait Anxiety Inventory*** ***Depression*** (Zung) ***Stanford Hypnotic Clinical Scale*** ***Analgesic use***	***HA index*** I: 42.6 (SD22.2); C1: 42.1 (SD 37.4); C2: 52.9 (SD 48.7) I vs. C1: SMD = −0.02 [−0.54–0.51]; I vs. C2: SMD = 0.28 [−0.27–0.82] (6 mo I vs. C1: SMD = −0.05 [−0.65–0.56]; I vs. C2: SMD = −0.20 [−0.78–0.39]) ***Depression:*** I vs. C1: SMD = 0.37 [−0.17–0.90]; I vs. C2: SMD = 0.52 [−0.03–1.08]; (6 mo I vs. C1: SMD = 0.29 [−0.32–0.89]; I vs. C2: SMD = 0.31 [−0.28–0.90]) ***Anxiety:*** I vs. C1: SMD = 0.2 [−0.33–0.73]; I vs. C2: SMD = 0.01 [−0.54–0.56]; (6 mo I vs. C1: SMD = 0.19 [−0.42–0.80]; I vs. C2: SMD = −0.04 [−0.62–0.55])

Ad Hoc, diagnosis according to the Ad Hoc Committee on the Classification of Headache; C1, control 1, C2, control 2, etc.; 4p, 4-point; HA, headache; hrs, hours; IHS, diagnosis according to the Headache Classification Committee of the International Headache Society; I, intervention; mo, months; N, number of subjects who where randomized for that group; nr, number; yrs, years; N/S, not stated; QS, quality score according to the Delphi list (item: positive score); RR, relative risk [95% confidence interval]; SMD, standard mean difference [95% confidence interval]; TTH, tension-type headache; VAS, visual analog scale; vs., versus; wk(s), week(s); WLC, waiting list control.

control (see Table 1), of which one provided sufficient data [47]. Relaxation + EMG biofeedback gave significantly lower headache index compared with attention placebo control.

Relaxation + EMG biofeedback versus other interventions

Relaxation + EMG biofeedback was compared with hypnotic analgesia in one study but no sufficient data were available [46]. No statistical significant differences were found in headache intensity between relaxation + EMG biofeedback and Shavasana therapy [64].

We conclude that there is limited evidence that relaxation + EMG biofeedback may be effective compared with attention placebo control.

Cognitive Behavioral Therapy

CBT versus placebo

Two studies compared CBT with placebo medication or self-monitoring control. One study provided sufficient data and found no significant difference [48]. Four studies evaluated the effect of additional CBT compared with relaxation [31,32,52,65] but found no significant differences in HA improvement, with the percentage of patients improved between 12 and 21% (see Table 3).

CBT versus other treatments

The two studies found no significant differences in HA improvement, depression, and anxiety between CBT and amitriptyline (n = 143) [48,66].

Table 2 Study characteristics of studies evaluating biofeedback treatment

Study	Participants	Interventions	Outcome measures	Results Post treatment (follow-up)
Arena et al. [51] QS: 5 (item: 1, 3, 4, 8, 10)	TTH (Ad Hoc). N = 27. 80.8% female; mean age: 39.5 yrs.	***I: Progressive muscle relaxation.*** Seven sessions in 8 wks, N = 8 ***C1: Frontalis EMG biofeedback.*** Twelve sessions in 6–9 wks, N = 9, 1 dropout. ***C2: Trapezius EMG biofeedback.*** Twelve sessions in 6–9 wks, N = 10	***HA improvement*** ***HA diary:*** 6p Likert scale; 4 times/day; HA index ***Analgesic use:*** index	***HA improvement:*** I: 37.5%; C1: 44.4%: C2: 100% I vs. C1: RR = 0.84 [0.27–2.68]; I vs. C1 + C2: RR = 0.51 [0.2–1.3]
Blanchard et al. [53] QS: 4 (item: 1, 3, 8, 10)	**Study 2.** Mixed (TTH and migraine) (Ad Hoc). N = 60. 77.1% female	***I: Clinical-based biofeedback + relaxation.*** Sixteen sessions in 8 wks, thermal biofeedback with thermometer, N = 29, 7 dropouts. ***C: Home-based biofeedback + relaxation.*** Three sessions in 8 wks + 2 telephone contacts (total 2.6 hrs), N = 31, 5 dropouts.	***HA improvement*** ***HA diary:*** 6p Likert scale; 4 times/day; in HA index ***Analgesic use:*** index	***HA improvement:*** I: 41.4%: C: 45.2% I vs. C: RR = 0.92 [0.51–1.64]
Budzynski et al. [38] QS: 1 (item: 1)	TTH. N = 18 dropouts were replaced. 88.9% female.	***I: EMG biofeedback.*** Sixteen sessions of frontalis EMG for 8 wks + home practice, N = 6, 4 dropouts. ***C1: Pseudo EMG biofeedback.*** Sixteen sessions of pseudo EMG + home practice, N = 6, 2 dropouts. ***C2: No training condition.*** N = 6	***HA diary:*** 6p Likert scale ***Minnesota Multiphasic personality Inventory*** ***EMG levels frontalis*** ***Analgesic use***	No sufficient data to calculate RR or SMD
Carrobles et al. [39] QS: 1 (item: 1)	TTH. N = 9, no dropouts; mean age: 38 yrs.	***I: EMG biofeedback.*** Eight sessions of frontalis EMG for 4 wks, N = 5 ***C: Pseudo EMG biofeedback.*** Eight sessions of "high expectations of cure" EMG for 4 wks, N = 4	***HA diary:*** frequency (hrs/day) ***Eysenck Personality Inventory*** ***Analgesic use:*** nr/day	No sufficient data to calculate RR or SMD

On the basis of the studies found, we cannot recommend or refute the use of CBT.

Discussion

On the basis of the available literature, we found conflicting evidence that relaxation, EMG feedback, or cognitive behavioral treatment (CBT) are better than attention or waiting list control groups in TTH patients. There is limited evidence that relaxation + EMG biofeedback may be effective compared with attention placebo control.

Contrary to other reviews [10–12], our systematic review focuses on RCTs only, and our search strategy identified a relatively large number of RCTs considering the treatment of patients with TTH alone (n = 44), compared with another systematic review (n = 35) [13]. Another review came to the conclusion that all the behavioral interventions were more effective than a

Table 2 Continued.

Study	**Participants**	**Interventions**	**Outcome measures**	**Results** Post treatment (follow-up)
Chesney and Shelton [33] QS: 3 (item: 1, 9, 10)	TTH. N = 24, no dropouts. 91.7% female.	***I: Muscle relaxation.*** Three sessions in 2 wks, N = 6 ***C1: EMG biofeedback.*** Ten sessions: 8 sessions of frontalis EMG four times a wk for 2 wks, N = 6 ***C2: Muscle relaxation + EMG biofeedback.*** N = 6 ***C3: No treatment condition.*** N = 6	***HA diary:*** VAS, frequency (nr/wk) and duration (hrs/HA)	No sufficient data to calculate RR or SMD
Cochrane et al. [46] QS: 2 (item: 1, 4)	TTH (Ad Hoc). N = 53, 5 dropouts.	***I: EMG biofeedback.*** Four weakly sessions of frontalis EMG N = ? ***C1: EMG biofeedback + relaxation.*** Four weakly sessions of frontalis EMG + relaxation, N = ? ***C2: Hypnotic analgesia.*** Four weakly sessions, N = ?	***HA diary:*** VAS and frequency (hrs/wk)	No sufficient data to calculate RR or SMD
Cram [40] QS: 2 (item: 1, 4)	TTH. N = 44, 12 dropouts. 78.1% female; mean age: 31.18 yrs.	***I: EMG-induced relaxation biofeedback.*** Three sessions of frontalis EMG, once a wk; N = 8 ***C1: EMG stability training biofeedback.*** Three sessions of frontalis EMG, once a wk; N = 8 ***C2: EMG meditation on tone biofeedback.*** Three sessions of frontalis EMG, once a wk; N = 8 ***C3: Headache monitoring.*** Three sessions of headache monitoring, once a wk; N = 8	***HA diary:*** intensity; HA index, frequency ***EMG levels***	No sufficient data to calculate RR or SMD
Gray et al. [60] QS: 2 (item: 1, 4)	TTH. N = 20, 5 dropouts. 60.0% female; mean age: 38.8 yrs.	***I: Direct EMG biofeedback.*** Six weakly sessions of frontalis and trapezius EMG; N = ? ***C1: Indirect EMG biofeedback.*** Six weakly sessions of frontalis and trapezius EMG; N = ? ***C2: Relaxation instructions.*** Six sessions of relaxation instructions + manual for home practice, N = ?	***HA diary:*** 5p Likert scale, frequency and duration ***Analgesic use***	No sufficient data to calculate RR or SMD
Hart and Cichanski [63] QS: 4 (item: 1, 3, 4, 10)	TTH (Ad Hoc). N = 24. 60.0% female; mean age: 33.2 yrs.	***I: Frontalis EMG biofeedback.*** Fifteen sessions of frontalis EMG, for 15 wks, N = 13, 3 dropouts. ***C: Neck EMG biofeedback.*** Fifteen sessions of neck EMG, for 15 wks, N = 11, 1 dropout.	***HA improvement*** ***HA diary:*** 6p Likert scale, frequency (nr days/wk); HA intensity $\geq$ 3, HA-free days (nr days/wk) ***Analgesic use:*** index	***HA improvement*** I: 23.1%; C: 36.4% I vs. C: RR = 0.63 [0.18–2.24]

Table 2 Continued.

Study	Participants	Interventions	Outcome measures	**Results** Post treatment (follow-up)
Haynes et al. [35] QS: 1 (item: 1)	TTH. N = 21. 66.7% female; mean age: 20.9 yrs.	***I: Relaxation.*** Six sessions twice weekly, N = 8, 2 dropouts. ***C1: EMG biofeedback.*** Six sessions of frontalis EMG, twice a wk, N = 8, 2 dropouts. ***C2: No treatment control.*** N = 5, 1 dropout.	***HA diary:*** 11p Likert scale, frequency, duration; HA index	No sufficient data to calculate RR or SMD
Holroyd et al. [9] QS: 6 (item: 1, 3, 4, 5, 7, 10)	TTH. N = 43, 5 dropouts. 76.3% female; mean age: 18.7 yrs.	***I: EMG biofeedback (high success) + decrease manipulation.*** Six sessions of frontalis EMG, for 3 wks; N = 9 ***C1: EMG biofeedback (high success) + increase manipulation.*** Six sessions of frontalis EMG, for 3 wks; N = 9 ***C2: EMG biofeedback (moderate success) + decrease manipulation.*** Six sessions of frontalis EMG, N = 10 ***C3: EMG biofeedback (moderate success) + increase manipulation.*** Six sessions of frontalis EMG, for 3 wks; N = 10	***HA diary:*** 11p Likert scale; HA activity, frequency (nr/wk), duration (hrs/wk), ***Self-efficacy***: 5p Likert scale ***Locus of control*** ***Analgesic use:*** nr/wk	No sufficient data to calculate RR or SMD
Hudzinski [67] QS: 2 (item: 1, 7)	TTH. N = 38, 8 dropouts. 60.0% female; mean age: 37 yrs.	***I: EMG biofeedback + relaxation + intensified muscle discrimination training.*** Ten sessions of frontalis and cervical EMG + relaxation + intensified muscle discrimination training, for 10 wks + home relaxation practice, N = 16 ***C: EMG biofeedback + relaxation.*** Ten sessions of frontalis and cervical EMG + relaxation, for 10 wks + home relaxation practice, N = 14	***EMG levels frontalis and cervical***	No sufficient data to calculate RR or SMD

waiting list control [13,14]. Unfortunately, we were not able to evaluate the differences between this systematic review and ours, because we were unable to retrieve this manuscript. Recently, a systematic review has been published focusing on the effectiveness of autogenic training alone in patients with TTH and also concluding that evidence to support this intervention was inconsistent [69]. Our systematic review provided valid results because it included more studies than the previous ones and had a strong study design to address our study question because we conducted the review procedures in duplicate and demonstrated a high level of agreement in our eligibility decisions and methodological assessments.

Strength and Limitations

Although systematic reviews offer the least biased method of summarizing research literature, our results

Table 2 Continued.

Study	**Participants**	**Interventions**	**Outcome measures**	**Results** Post treatment (follow-up)
Janssen [41] QS: 2 (item: 1, 3)	TTH. N = 18, no dropouts. 77.8% female; mean age: 34.6 yrs.	***I: EMG biofeedback.*** Twelve sessions for 6 wks of frontalis EMG, N = 6 ***C1: EMG biofeedback + relaxation.*** Two relaxation sessions + home exercises + 10 sessions for 5 wks of frontalis EMG, N = 6 ***C2: Waiting list control.*** Baseline, 5 wks waiting, 3 recording sessions in 18 days, N = 6	***HA diary:*** 6p Likert scale and duration; HA index ***EMG levels frontalis and neck***	No sufficient data to calculate RR or SMD
Kondo and Canter [48] QS: 6 (item: 1, 3, 5, 6, 7, 8)	TTH + mixed. N = 20 completed. 90.0% female; age range: 19–38 yrs.	***I: EMG biofeedback.*** Ten sessions of frontalis EMG, in 3 wks, N = 10 ***C: Pseudo EMG biofeedback.*** Ten sessions of taped frontalis EMG, in 3 wks, N = 10	***HA diary:*** frequency (nr/day) ***EMG levels frontalis***	***HA frequency*** I: 1.0 (SD 0.93); C: 3.5 (SD 0.96); I vs. C: SMD = 2.53 [1.36–3.71]
Mathew [49] QS: 2 (item: 1, 8)	TTH / mixed. N = 375. 95.5% female; mean age: 40.2 yrs.	***I: Biofeedback.*** 10 × 60 min in 28 wks, N = 52, 21 dropouts. ***C1: Propranol 60–160 mg.*** N = 48, 10 dropouts. ***C2: Amitriptyline 25–75 mg.*** N = 44, 13 dropouts. ***C3: Propranol + biofeedback.*** N = 43, 9 dropouts. ***C4: Amitriptyline + biofeedback.*** N = 46, 7 dropouts.***C5: Propranol + amitriptyline.*** N = 47, 11 dropouts. ***C6: Propranol + amitriptyline + biofeedback.*** N = 46, 9 dropouts. ***C7: Control.*** Abortive treatment: ergotamine, N = 49, 14 dropouts.	***HA diary:*** frequency and severity; HA index ***HA improvement (continuous)*** ***Depression:*** Zung self-rating Depression Scale ***Adverse events:*** N/S	***HA improvement*** I: 48%; C1: 52%; C2: 60%; C7: 18% ***HA improvement*** I vs. C1: SMD = −1.83 [−2.39 to −1.26]; I vs. C2: SMD = −1.85 [−1.25 to −2.44]; I vs. C7: SMD = 4.14 [3.28–4.99]; ***Depression:*** I vs. C1: SMD = 1.0 [0.49–1.80]; I vs. C2: SMD = −0.24 [−0.74–0.26]; I vs. C7: SMD = 0.33 [−0.16–0.82];

should be considered with the following limitations in mind. First, we decided not to contact the authors for additional information, because most trials included in this review were published before 1998 and so we might not be able to find all authors. This might lead to bias, although it is impossible to reach all authors, and it is uncertain whether information retrieved from some of the authors might lead to less bias. Second, most modalities have only been evaluated in one or two studies, which limits the generalizability of the findings. Third, many RCTs on the efficacy of behavioral treatment in TTH have methodological shortcomings. Using our cut-off point, only 11.6% of the included studies were found to have low risk of bias. The methodological components were assessed using the Delphi list, a generic list meant to be used in different research areas and often used in studies

Table 2 Continued.

Study	Participants	Interventions	Outcome measures	**Results** Post treatment (follow-up)
Paiva et al. [44] QS: 6 (item: 1, 5, 6, 7, 8, 10)	TTH (Ad Hoc). N = 36. 75.0% female; mean age: 37.5 yrs.	***I: Biofeedback true.*** Three sessions/wk for 4 wks, N = 9, 1 dropout. ***C1: Biofeedback false.*** Three sessions/wk for 4 wks, N = 9, 1 dropout. ***C2: Diazepam.*** 4 wks, N = 9, 1 dropout. ***C3: Diazepam placebo.*** 4 wks, N = 9, 1 dropout.	***HA diary:*** intensity and frequency ***Adverse events:*** N/S	***HA intensity:*** I: 1.04 (SD 0.74); C1: 1.06 (SD 0.86); C2: 0.88 (SD 0.66); C3: 1.51 (SD 0.88) I vs. C1: SMD = 0.02 [−0.96–1.0]; I vs. C2: SMD = −0.22 [−1.2–0.77]; ***HA frequency:*** I vs. C1: SMD = 0.72 [−0.3–1.74]; I vs. C2: SMD = 0.39 [−0.61–1.38];
Philips [45] QS: 3 (item: 1, 3, 8)	TTH and mixed. N = 15.	***I: EMG biofeedback.*** Twelve sessions for 6 wks of frontalis or temporalis EMG, N = 8, 3 dropouts post treatment. ***C: Pseudo EMG biofeedback.*** Twelve sessions for 6 wks of taped frontalis or temporalis EMG, N = 7, 2 dropouts post treatment and 2 at follow-up.	***HA diary:*** Budzynski scale (nr/wk) ***EMG levels frontalis*** ***Analgesic use:*** nr	No sufficient data to calculate RR or SMD
Reich [61] QS: 1 (item: 1)	TTH. N = ?, N = 311 completed. 52% female.	***I: EMG biofeedback.*** Ten session for 15 wks of frontalis, trapezius or paracervical EMG + home practice, N = 78 ***C1: Relaxation.*** Either cognitive-oriented psychotherapy, hypnosis, or autogenic training/progressive muscle relaxation, single or in combination + home practice, N = 78 ***C2: Electrical treatment.*** Either traditional TENS or electrical neurotransmitter modulation, single or in combination, N = 74 ***C3: Combination treatment.*** A combination of two of the above treatment groups, N = 81	***HA diary:*** 5p Likert scale and frequency (hrs/wk)	No sufficient data to calculate RR or SMD

evaluating physiotherapy interventions [70–72]. These interventions often have the same methodological difficulties as behavioral interventions (such as blinding issues), yet they seem to be able to perform RCTs with lesser methodological shortcomings. Blinding of patients and therapists is difficult, and when the patients assess the primary outcome, blinding of the outcome assessor is also not possible. In theory, not blinding patients and therapists does not have to lead to biased results. When therapists only provide one treatment (intervention or control) and patients do not have a treatment preference, bias will probably be negligible. To assess the sources of bias, it is necessary that authors provide information about these issues in the manuscript. Therefore,

Table 2 Continued.

Study	**Participants**	**Interventions**	**Outcome measures**	**Results** Post treatment (follow-up)
Bell et al. [25,26] QS: 1 (item: 1)	TTH (Ad Hoc). N = 31, 7 dropouts. 83.3% female; mean age: 33.5 yrs.	***I: Broad-gauged biofeedback.*** Twice weekly for 6 wks, of EMG relaxation, N = ? ***C1: Electric psychotherapy.*** Six weekly sessions, N = ? ***C2: Broad-gauged biofeedback + electric psychotherapy.*** Psychotherapy following second EMG session, N = ? ***C3: Waiting list control.*** Weekly contact by phone, N = ?	***HA improvement*** ***HA diary:*** 5p Likert scales ***Health Locus of Control Scale:*** external ***EMG levels frontalis*** ***Analgesic use:*** nr	No sufficient data to calculate RR or SMD

Ad Hoc, diagnosis according to the Ad Hoc Committee on the Classification of Headache; C1, control 1, C2, control 2, etc.; 4p, 4-point; HA, headache; hrs, hours; IHS, diagnosis according to the Headache Classification Committee of the International Headache Society; I, intervention; mo, months; N, number of subjects who where randomized for that group; yrs, years; nr, number; N/S, not stated; QS, quality score according to the Delphi list (item: positive score); RR, relative risk [95% confidence interval]; SMD, standard mean difference [95% confidence interval]; TTH, tension-type headache; VAS, visual analog scale; vs., versus; wk(s), week(s); WLC, waiting list control.

we assume that there is room for improvement of the methodological components of behavioral research. Even without assessing the risk of bias, our conclusions would not be dramatically different; only a few interventions showed statistical significant results. Fourth, a large number of studies (especially concerning EMG feedback) suffered from insufficient data presentation; 34.1% of the trials did not provide any data on outcome measures. The advantage of a systematic review is that results of small studies can be statistically pooled to one overall effect estimate. Unfortunately, this was not possible due to the lack of data and clinical heterogeneity. Finally, many studies are of low power, with sample sizes of less than 10 patients per treatment arm. More recent studies tend to have sample sizes varying from 10 to 20 people in each treatment arm, but are still considered underpowered. The percentage of improvement varied enormously between studies, but because of the low power of the studies, it seldom reached statistical significance. Our conclusions are certainly influenced by the wide variety of treatment modalities, the low power, and the methodological shortcomings of the studies found.

For primary headaches, such as TTHs, there are no biological markers, and therefore, their diagnosis is made on the basis of diagnostic criteria of the IHS, which were updated in 2004 [4,5]. Nowadays, this diagnosis can be made with relatively high precision [73]. However, just four studies included in this review used the criteria of the IHS to classify chronic TTH; 16 studies used the Ad Hoc criteria, leaving more than half of the studies not using predefined criteria for their selection of the study population. This might raise problems, because it remains unclear whether all included patients actually suffer from TTH, and therefore might influence the outcome of the studies. For future trials, it is important that authors adhere to predefined diagnostic criteria [4,5].

It is difficult for any prophylactic treatment to show additional benefit, taking the favorable natural course of TTH into account; almost half of all chronic TTH sufferers experience remission of complaints, especially with increasing age [1,73]. "HA improvement," which was a main outcome measure in most studies, was defined so that only people with over 50% improvement were considered improved. This outcome measure is frequently used in behavioral studies, but we consider a 50% improvement a large improvement, maybe too large to find differences between groups. The Philadelphia panel advices cut-off scores for clinically relevant differences of 15% improvement [74]. Maybe other outcome measures or other cut-off scores between recovered or not recovered patients may be considered in future trials.

In conclusion, on the basis of the available literature, we found no clear indications for the use of relaxation, EMG biofeedback, or cognitive behavioral treatment. This review shows that there is a clear need of large, multicentered research with low risk of bias evaluating behavioral treatment of patients with TTH. Favorably, studies should

Table 3 Study characteristics of studies evaluating other treatments

Study	**Participants**	**Interventions**	**Outcome measures**	**Results** Post treatment (follow-up)
Figueroa [49] QS: 5 (item: 1, 3, 4, 5, 7)	TTH. N = 15, no dropouts. 73.4% female; mean age: 33.9 yrs.	***I: Behavioral training.*** Seven sessions twice weekly of problem-solving techniques, progressive relaxation, anxiety management, stress inoculation and pain manipulation, N = 5 ***C1: Psychotherapy.*** Seven sessions twice weekly of headache discussion and conflict resolution process, N = 5 ***C2: Self-monitoring control.*** N = 5	***HA diary:*** 7p Likert scale, ***Disability degree:*** 9p Likert scale ***Relaxation level:*** 7p Likert scale ***Analgesic use:*** nr/wk	No sufficient data to calculate RR or SMD
Holroyd [66] 1991 QS: 5 (item: 1, 3, 4, 8, 10)	TTH. N = 41. 80.5% female; mean age: 32.3 yrs.	***I: Cognitive behavioral therapy.*** Three sessions + 2 telephone conversation, N = 20, 1 dropout. ***C: Amitriptyline 50–75 mg.*** 12 wks, N = 21, 4 dropouts.	***HA improvement*** ***HA diary:*** 10p Likert scale; ***Depression:*** Beck Depression Inventory ***Anxiety:*** State Trait Personality Inventory ***Analgesic use:*** nr/day ***Adverse events***	***HA improvement*** I: 35%; C: 14.3% I vs. C: RR = 2.45 [0.73–8.18] ***Depression:*** I vs. C: SMD = 0.07 [−0.58–0.73] ***Anxiety:*** I vs. C: SMD = 0.14 [−0.52–0.79] ***Analgesic use:*** I vs. C: SMD = 0.62 [−0.05–1.29] ***Adverse events:*** I: 0% vs. C: 62.5%
Holroyd [48] 2001 QS: 5 (item: 1, 3, 4, 8, 9)	TTH (IHS) N = 203. 76.4% female; mean age: 37.0 yrs.	***I: Stress management.*** Three sessions in 8 wks, N = 49, 15 dropouts. ***C1: Amitriptyline 12.5–50 mg.*** for 8 wks, N = 53, 9 dropouts. ***C2: Stress management + amitriptyline.*** N = 53, 13 dropouts ***C3: Placebo.*** N = 48, 22 dropouts.	***HA improvement*** ***HA diary:*** 10p Likert scale; in HA index, frequency (nr days/mo) ***Analgesic use:*** nr/day ***Adverse events***	***HA improvement*** I: 34.7%; C1: 37.7%; C2: 64.2%; C3: 29.2% 6 mo I vs. C1: RR = 0.92 [0.55–1.54]; I vs. C2: RR = 0.54 [0.35–0.83]; I vs. C3: RR = 1.19 [0.66–2.13]; C1 vs. C2: RR = 0.59 [0.39–0.88]

Ad Hoc, diagnosis according to the Ad Hoc Committee on the Classification of Headache; C1, control 1, C2, control 2, etc.; 4p, 4-point; HA, headache; hrs, hours; IHS, diagnosis according to the Headache Classification Committee of the International Headache Society; I, intervention; mo, months; N, number of subjects who where randomized for that group; nr, number; yrs, years; N/S, not stated; QS, quality score according to the Delphi list (item: positive score); RR, relative risk [95% confidence interval]; SMD, standard mean difference [95% confidence interval]; TTH, tension-type headache; VAS, visual analog scale; vs., versus; wk(s), week(s); WLC, waiting list control.

be performed and reported according to the Consolidated Standards of Reporting Trials (CONSORT) statement [75].

Implications for clinicians At this moment, there is no clear evidence available to support (or refute) the use of any behavioral treatment. This means that clinicians are not guided in their treatment decisions in an evidence-based way and should rely on their clinical expertise. Nevertheless, the most promising treatment option is a combined treatment of relaxation + EMG biofeedback.

Implications for research Large and more methodological robust studies should be performed evaluating preferably relaxation or biofeedback. Attention should be paid to the use of the IHS diagnostic criteria for patient selection and the CONSORT statement when reporting the results.

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Conflict of Interest

The authors have no conflict of interest.

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